9.2.4 Horizontal driver

Res:	R38	220R	R43	68R 5W
	R41	120R	R46	220R
Cap:	C24	100 nF	C52	100 nF
	C25	1 nF	C53	47 uF
	C26	47 nF		
Tran:	Q9	BD131		
Xform:	TX2			

The output of the horizontal IC is fed thru R38, R46, C24 and C25 to Q9, which drives the primary of TX2. R41 and C26 are connected across TX2 to reduce ringing, and R43, C52 and C53 decouple the 24 V supply to this section.

9.2.5 Horizontal output

Res:	R44	1R 0.5W	R71	2R2 5W
	R45	68R		
Cap:	C27	1 nF	C33	1 uF
	C28	12 nF 1.5 kV	C54	100 nF
	C32	1 uF 400 V	C55	100 uF 40 V
Tran:	Q10	BU246		
Diode:	D6	BYW96E	D8	BY229/400
Xform:	TX1	Horizontal flyback transformer		

Here is what can be called the heart of the circuit, as so much depends on its proper operation. The horizontal flyback transformer drives not only the horizontal trace, but all the HT supplies, the EHT for the tube anode and the heater supply. It also does all this from a single 24 V supply.

Q10 is set up as a switch between ground and one end of TX1's primary. The other end of the primary is connected via D8 and C33 to a decoupled 24 V supply. When Q10 is turned on, current flows thru the primary via D8, setting up a magnetic field in TX1. When Q10 is turned off, this field collapses, and its energy appears in the form of a large voltage across the primary (better known as the "flyback" pulse).

9.2.7 Output conditioning

Res:	R47	1k8	R48	1k8	
Cap:	C29	1 uF 400 V	C30	470 nF	400 V
Coil:	L1	Horizontal width			
	L2	Horizontal linearity			

This section conditions the horizontal drive to ensure linearity and width are correct. The two coils form an adjustable series LC with the capacitors and deflection coils, and the current waveform determines deflection behaviour. Only the linearity coil is adjustable; the width coil was found to work better without its tuning slug. Thus there may be small differences in the screen width of different monitors, but this has not been a problem.

Faint vertical stripes on a bright raster would indicate ringing around the coils, which can be caused by open or faulty damping resistors R47 and R48. Lack of picture can be caused by open circuits in this chain; this crashes the energy cycle of the flyback transformer which provides the important supplies.

9.2.8 Dynamic focus

Res:	R74	68R			
Cap:	C31	1 nF 1 kV	C59	1 nF	1 kV
Xform:	TX3	Dynamic focus			

Dynamic focus is necessary because of the wide angle of deflection (110 degrees). The beam path at the edge of the tube is much longer than the path at the centre. Focussing the whole horizontal trace would be a compromise without some means of compensating for the different path lengths. This is accomplished by adjusting the focus voltage according to the horizontal deflection.

TX3 supplies this adjustment signal; its primary is in series with the deflection coils. The signal appearing at the secondary is passed thru C31 and mixed with the fixed focus voltage thru R57. If this is not working, it will be impossible to focus adequately along the whole trace length.

9.3. VERTICAL SECTION

Like the horizontal section, this provides everything necessary to maintain a sweep on the screen. It can be broken up into the following sections:

Sync conditioning
Vertical oscillator
Vertical IC decoupling
Output/feedback

9.3.1 Sync conditioning

Res:	R137	4k7
Cap:	C132	10 nF
Diode:	D108	BAW62

This network cleans up the sync from either the sync separator or the optional sync input, which is then fed to TDA 2653 pin 2.

9.3.2 Vertical oscillator

Res:	R139	39k	R150	18k
	R148	270R	R154	68k
	R149	220k		
	VR40	50k	Vertical frequency adjust	
Cap:	C133	100 uF	C139	470 nF
	C136	47 uF		

This network is required by the vertical combination IC to generate the vertical timebase. It can be separated into four smaller networks as follows:

Pin 1: VR40 in series with R139.

Pin 7: RC network (C133, R148) between 24 V and ground.

Pin 10: RC network (R149, R150, C136) between 24 V and gnd.

Pin 13: Parallel RC (R154, C139) to ground.

The problems common to this area are similar to those of the horizontal timebase network. The stability of the trace depends on these networks operating correctly; faults may also affect linearity or size.

9.3.3 Vertical IC decoupling

Res:	R146	6R8 1W		
Cap:	C134	1000 uF	C143	1000 uF
	C135	100 nF		
Diode:	D110	BYV96E		
IC:	U2	TDA 2653A	Vertical combination	

For stable operation, this section needs good decoupling. C135 and C143 bypass the supply to pin 9 for the timebase. The output driver supply to pin 5 is decoupled by R146, C134 and D110. Ground is connected to pin 8. Longterm stability problems can start here, e.g. intermittent flicker or jumping.

9.3.4 Output/feedback

Res:	R73	270R	R157	120R
	R143	39k	R158	18k
	R144	68k	R159	820R
	R145	3k3	R161	22k
	R151	22k	R162	1R5
	R152	2M7	R163	1R5
	R153	1M5	R164	5R6 1W
	R155	4k7		
Cap:	C137	100 nF	C141	1000 uF
	C138	100 nF	C142	100 nF
	C140	2.2 uF		
Diode:	D111	BAW62		

This mass of circuitry provides the feedback and adjustment for linearity and level. The output is driven directly from the IC (hence the heatsink) via pin 6. The return current flows thru C141 and then R162 and R163 which act as current sense resistors. R73 provides damping for the deflection coils, and the RC network of R164 and C142 provides further output "tuning".

Voltage feedback is taken from the coil return thru R161 and R158 with a series RC to ground (C140, R159). Current feedback is taken from R162 and R163 via R157 and trimpot VR56, providing vertical amplitude adjustment. These two feedback signals are mixed by R155 and R158 at pin 4 of the IC. This combined feedback also feeds R143, R145, pin 3 and VR47 (vertical linearity). It then passes thru the network consisting of R144, C138, C137, R151, D111, R152 and R153 to finally enter pin 11 of the IC.

Faultfinding in this area is difficult. Probably the best way to remove suspicion is to check all components for faults or changes in value. The main feedback paths should also be looked at for obvious faults. Further than this, another monitor should be used to compare signals.

9.4 HT AND EHT VOLTAGES

These voltages are generated by the horizontal flyback transformer to supply the tube.

Cathode/brightness supplies
Focus/G2 supply
EHT tripler supply
Tube heater supply

9.4.1 Cathode/brightness supplies

Res:	R51	1k		R53	2M2
	R52	1M			
	VR8	1M	Brightness adjustment		
Cap:	C34	10 uF 350 V		C58	2.2 uF 160 V
Diode:	D9	BYV96E		D11	BY584

The winding between pins 3 and 5 supplies +85 V, rectified by D9 and C58. This is used to supply both the cathode circuit on the tube support card (P5 pin 5) and one leg of the brightness control (via R52).

The winding between pins 6 and 7 provides two supplies; the focus/G2 supply (described in the next section), and -155 V, rectified by R51, D11 and C34. This connects via R53 to the other leg of the brightness control. The connections to this control pass thru P1 as follows:

Pin 4	+85 V
Pin 5	Adjustment voltage return
Pin 6	-155 V

The voltage returned is then sent to the tube support card via P5 pin 4. C34 on the negative supply is deliberately large to prevent spot burn, by maintaining bias on the grid after switch-off.

Overvoltage is possible, and can be dangerous, especially if component ratings are exceeded (capacitors do explode if provoked). This section should always be checked in a repair or test situation.

9.4.2 Focus/G2 supply

Res:	R50	1k8	
	R57	1M8	
	R54	1M5	High voltage type (blue)
	R56	1M5	High voltage type (blue)
	VR9	2M7	Focus adjustment pot
Cap:	C35	10 nF	1.6 kV
Diode:	D10	BY584	

This is a +800 V supply derived from the winding between pins 6 and 7, rectified by R50 and D10. The G2 +400 V supply is divided down by special high voltage resistors R54 and R56, passing to the tube support card via P5 pin 7. The focus adjust pot is connected directly across the +800 V supply. The static focus voltage is mixed thru R57 with the dynamic focus signal at C31, the composite then passing to the tube support card via P5 pin 9.

This section can be lethal due to the high voltages present. It should be checked (carefully) to avoid the possibility of dangerous overvoltage.

It is essential that high voltage resistors be used for R54 and R56; normal resistors are likely to fail within a year or two. This will cause the screen to either go blank or to full brightness, depending on which resistor fails.

9.4.3 EHT tripler supply

Diode: Internal stack in horizontal xformer

This is hermetically sealed within the transformer. A special high insulation cable takes the voltage out to a point on the back of the tube. The return end of the winding is grounded thru pin 13. The voltage developed is approx 17 kV, which for obvious reasons should be treated with great care.

If any part of this connection is exposed to air, the voltage will start to "bleed off" which sounds like white noise or hissing. The sharp edges of the transformer may also do this if too close enough to another component. Usually the smell of ozone appears as well.

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**************************************************************
**                                                          **
**  WARNING - DO NOT ATTEMPT THE FOLLOWING PROCEDURE        **
**  IF YOU ARE NOT EXPERIENCED IN DEALING WITH E.H.T.       **
**  VOLTAGES (17 kV).                                       **
**                                                          **
**************************************************************
```

To discharge and disconnect the lead from the back of the tube, follow these instructions strictly:

1. Disconnect video signal from monitor. This prevents spikes propagating into the CMI and crashing the system.

2. Turn mains power off at the switch. It is important to leave the power lead connected to ensure chassis grounding. Otherwise the energy liberated by discharging can cause the chassis to float up to a dangerous voltage. Make sure the mains is actually off though.

3. Discharge the EHT to the chassis. This can be done by connecting a clip lead between the chassis and a screwdriver, and inserting the tip of the screwdriver under the plastic cap which protects the tube connection. Obviously use a long enough screwdriver with a well insulated handle for safety. The voltage will spark over as the tip is brought near; it should then be touched to the connector to completely discharge it.

4. While the screwdriver tip is in this position, the connector can be "unhooked" by applying pressure to push the hook clear of the lip which forms the tube connection.

5. It is now possible to remove the lead, holding it by the back of the protective plastic cap and disengaging it from the rear of the tube. However, avoid touching either of the exposed parts of the connection as residual charge may still be present.

6. When reconnecting the EHT lead to the tube, avoid touching either contact as residual charge may still be present. Ensure that the "hook" is properly engaged and the connection is firm. Sometimes this involves a bit of force; perhaps using a screwdriver to push the hook back under the lip would make this easier.

9.4.4 Tube heater supply

Res: R49 10R 5W

The winding between pins 1 and 2 is a 6.3 V floating heater supply, and passes to the tube support card via P5 pins 2 and 3. R49 limits the current.

To check the operation of the heater, look for the glow towards the back of the tube neck.

This combines the video and blanking signals and provides an output stage to drive the cathode. It also supplies and limits the necessary voltages to the rear of the tube:

Video output/blanking
Supplies/signals
Overvoltage spark gap

It also has a black level adjustment.

10.1 Video output/blanking

Res:	R18	680R	R22	470R
	R19	56R	R72	39R
	R20	1k2 5W		
	VR2	1k	Black level adjustment	
Cap:	C51	270 uF		
Tran:	Q5	BC549	Q7	BSX20
	Q6	BF337		

A 7.5 V reference is supplied to the base of Q6. Q6's emitter therefore can set the current flowing through the cathode chain: R19, R20, R72, Q6, Q7 and C51. R20 varies the voltage on the cathode as this current varies, thus changing the beam current.

Three things can influence Q6's emitter: VR2 sets the no-signal beam current i.e. black level. The mixed blanking signal turns Q5 on which shuts down Q6, cutting off the beam current. Video signals turn Q7 on, saturating Q6 and increasing beam current. This circuit mixes the three signals and provides output drive. R22 provides some current limiting.

The flying ground lead which clips into the chassis ground lead can cause problems if not soldered properly at the board. A dry joint can create a fuzzy or jittery picture.

10. VDU02 TUBE SUPPORT CARD FUNCTIONAL DESCRIPTION (continued)

10.2 Supplies/signals

Res:	R17	680R	R24	220k
	R21	47R	R33	22k
Cap:	C6	10 nF	C9	100 nF
	C7	22 nF	C10	100 nF 400V
	C8	22 uF	C11	10 nF 1kV
Diode:	D4	7.5 V Zener		

This section covers six areas:

12 V supply to Q5, decoupled by C6.

7.5 V ref. to Q6, generated from 12 V by R17, D4 and C7.

85 V supply to cathode chain, decoupled by R21, C8 and C9.

Brightness control voltage, bypassed by C10.

400 V (G2) supply via R33 and C11.

Focus voltage via R24.

10.3 Overvoltage spark gap

Incorporated into the board layout is a ground ring around the inside of all the tube connections. If any voltage goes dangerously high, the excess energy will arc over and be dissipated.

14. MECHANICAL PARTS LIST

14.1 PARTS LIST FOR DRAWING MQ215L/01

Ref No.	Part No.	Description.
1	G5152	Light Pen Socket
2	G5151	Light Pen
3	J0209	Front Panel Assy.
4	J0208	Base Panel
5	G5191	Power Transformer
6	G0073	Power Supply Base Plate
7	G5159	Voltage Selector Switch
8	J0040	Rear Panel Escutcheon
9	G5190	Fuse Holder Cap
10	G5309	Fuse Holder
11	D6768	Power Connector 3 pin
12	D6710	Graphics Connector 5 pin
13	G0128	P.C.B. Bracket
14	G0127	Support strip
15	G0124	Support Panel LH
16	G0126	Support bracket
17	G0125	Support Panel RH
18	MVDU02	CRT Card VDU02
19	MVDU01	Main Card VDU01
20	G5184	Deflection Yoke
21	G5198	Picture Tube 15"
22	G6017	eht cable
23	MVDU03	P.S.U. Card VDU03
24	R6111	Contrast Pot
25	R6110	Brightness Pot
26	G5107	P.C.B. Standoff
27	H0125	Screw 6Gx1/4"
28	H0102	Screw CHD4BAx"
29	H0111	Screw CKS 4BAx15/16"
30	H0118	Screw CKS6BAx3/8"
31	H0115	Screw 4Gx3/8"
32	H0140	Stud 1/4"W
33	H0133	Screw CHD 4BAx1/4"
34	H0008	Washer 4BA star
35	H0021	Washer Pot
36	H0139	Washer 1/4"W Star
37	H0012	Washer 6BA Star
38	H0202	Nut 4BA Hex
39	H0208	Nut Fuseholder
40	H0201	Nut 6BA Hex
41	H0020	Nut Pot

14. MECHANICAL PARTS LIST (continued)

14.2 PARTS LIST FOR DRAWING MQ215L/02

Ref.No.	Part No.	Description.
1	J0209	Front Panel
2	J0271	Top Cover
3	J0208	Base Panel
4	J0006	Foot
5	H0132	Screw 1/4"x1"
6	H0103	Screw 8Gx3/4" CHD
8	H0209	Nut